

Claims:

1. (Currently amended) A vulcanizate comprising:

a vulcanized rubber formulation comprising at least one vulcanized rubber and a filler, where the at least one vulcanized rubber includes a vulcanizate of a sequentially functionalized polymer that is prepared by

reacting an anionically polymerized living polymer with a functionalizing agent X' to produce an end-functionalized polymer that will react or interact with carbon black, silica, or both and that comprises a reactive electrophilic or nucleophilic site; and

reacting the reactive site with a functionalizing agent Y' to produce a sequentially functionalized polymer that will react or interact with carbon black and silica, where Y' is (i) an isocyanato alkoxy silane compound selected from the group consisting of gamma-isocyanatopropyl-triethoxysilane, gamma-isothiocyanatopropyl-triethoxysilane, gamma-isocyanatopropyl-trimethoxysilane, and gamma-isothiocyanatopropyl-trimethoxysilane epichlorohydrin, or (ii) an epoxy-generating reagent selected from the group consisting of epibromohydrin, triethoxysilyl propyl chloride, diethoxymethylsilyl propyl chloride, diethylcarbamy chloride, 1-(3-bromopropyl)-2,2,5,5-tetramethyl-1-aza-2,5-disilacyclopentane, a multi-epoxidized high-vinyl polybutadiene, a multi-epoxidized high-vinyl oligo-butadiene, a multi-epoxidized high-vinyl polyisoprene, and a multi-epoxidized high-vinyl oligo-isoprene, or (iii) a short-chain polymer group.

2. (Original) The vulcanizate of claim 1, where the anionically polymerized living polymer is a copolymer of styrene and 1,3-butadiene.

3. (Original) The vulcanizate of claim 1, where X' comprises 1,3-dimethylimidazolidinone, N-methylpyrrolidinone, dicyclohexylcarbodiimide, benzonitrile, a substituted nitrile, a substituted aziridine, a thiazoline, a dialkylaminobenzaldehyde, a bis(dialkylamino)benzophenone, a substituted epoxy compound, N-methylcaprolactam, a substituted Schiff base, a substituted styrylmethyl derivative, vinyl pyridine, a short block of polyvinylpyridine, a polysulfoxide, a poly(carbodiimide), a poly(meth)acrylamide, a poly(aminoalkyl(meth)acrylate),

polyacrylonitrile, polyethylene oxide, butyl glycidyl ether, monoglycidyl siloxane, polysiloxane with epoxide endgroups, diphenyl ethylene, or a functionalized styrene.

4. (Original) The vulcanizate of claim 1, where X' comprises 1,3-dimethylimidazolidinone, 3-glycidoxypropyltrimethoxysilane, N-methylpyrrolidinone, or monoglycidyl ether terminated poly(dimethylsiloxane).

5-7 cancelled

8. (Original) The vulcanizate of claim 1, where the filler includes carbon black, silica, or a mixture thereof.

9. (Original) The vulcanizate of claim 1, where the vulcanizate further includes a vulcanized natural rubber or vulcanized synthetic rubber other than the sequentially functionalized polymer.

10. (Currently amended) A method for preparing a sequentially functionalized polymer, the method comprising:

reacting an anionically polymerized living polymer with a functionalizing agent X' to produce an end-functionalized polymer that will react or interact with carbon black, silica, or both and that comprises a reactive electrophilic or nucleophilic site; and

reacting the reactive site with a functionalizing agent Y' to produce a sequentially functionalized polymer that will react or interact with carbon black and silica, where Y' is (i) an isocyanato alkoxy silane compound selected from the group consisting of gamma-isocyanatopropyl-triethoxysilane, gamma-isothiocyanatopropyl-triethoxysilane, gamma-isocyanatopropyl-trimethoxysilane, and gamma-isothiocyanatopropyl-trimethoxysilane epichlorohydrin, or (ii) an epoxy-generating reagent selected from the group consisting of epibromohydrin, triethoxysilyl propyl chloride, diethoxymethylsilyl propyl chloride, diethylcarbaryl chloride, 1-(3-bromopropyl)-2,2,5,5-tetramethyl-1-aza-2,5-disilacyclopentane, a multi-epoxidized high-vinyl polybutadiene, a multi-epoxidized high-vinyl oligo-

butadiene, a multi-epoxidized high-vinyl polyisoprene, and a multi-epoxidized high-vinyl oligo-isoprene, and multi-epoxidized high-vinyl, or (iii) a short-chain polymer group.

11. (Original) The method of claim 10, where the anionically polymerized living polymer is a copolymer of styrene and 1,3-butadiene.

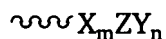
12. (Original) The method of claim 10, where X' comprises 1,3-dimethylimidazolidinone, N-methylpyrrolidinone, dicyclohexylcarbodiimide, benzonitrile, a substituted nitrile, a substituted aziridine, a thiazoline, a dialkylaminobenzaldehyde, a bis(dialkylamino)benzophenone, a substituted epoxy compound, N-methylcaprolactam, a substituted Schiff base, a substituted styrylmethyl derivative, vinyl pyridine, a short block of polyvinylpyridine, a polysulfoxide, a poly(carbodiimide), a poly(meth)acrylamide, a poly(aminoalkyl(meth)acrylate), polyacrylonitrile, polyethylene oxide, butyl glycidyl ether, monoglycidyl siloxane, polysiloxane with epoxide endgroups, diphenyl ethylene, or a functionalized styrene.

13. (Original) The method of claim 10, where X' comprises 1,3-dimethylimidazolidinone, 3-glycidoxypropyltrimethoxysilane, N-methylpyrrolidinone, or monoglycidyl ether terminated poly(dimethylsiloxane).

14-16 cancelled

17. (Original) The method of claim 10, further comprising the step of reacting the reactive site with a chain-extending group Z to form a chain-extended functionalized polymer that comprises a reactive electrophilic or nucleophilic site.

18. (Original) A functionalized polymer defined by the formula



where $\sim\sim\sim$ is an anionically polymerized polymer segment, X comprises a first functional group that will react or interact with carbon black, silica, or both, Y comprises a second functional group that will react or interact with carbon black, silica, or both, Z

is a bond or a chain-extending group, and m and n are each integers from 1 to about 50, with the proviso that when X will react or interact with carbon black but not with silica, Y will react or interact with silica, and when X will react or interact with silica but not with carbon black, Y will react or interact with carbon black.

19. (New) A method for preparing a sequentially functionalized polymer, the method comprising:

reacting an anionically polymerized living polymer with a functionalizing agent X' to produce an end-functionalized polymer that comprises a reactive electrophilic or nucleophilic site; and

reacting the reactive site with a functionalizing agent Y', where at least one of X' and Y' provides the sequentially functionalized polymer with an amine group or an alkyl tin group, and where at least one of X' and Y' provides the sequentially functionalized polymer with an alkoxy silane or epoxide group.

20. (New) The vulcanizate of claim 1, where X' is a functionalizing agent selected from the group consisting of 1,3-dimethylimidazolidinone and N-methylpyrrolidinone, and where Y' is selected from the group consisting of isocyanato alkoxy silane compounds and epoxy-generating reagents.

21. (New) The method of claim 10, where X' is a functionalizing agent selected from the group consisting of 1,3-dimethylimidazolidinone and N-methylpyrrolidinone, and where Y' is selected from the group consisting of isocyanato alkoxy silane compounds and epoxy-generating reagents.

22. (New) The method of claim 19, where X' is selected from the group consisting of monoglycidyl siloxanes and monoglycidyl ether-terminated polysiloxanes, and where Y' is selected from the group consisting of N,N-diethyl amino carbonyl chloride, tributyltin, and 1-(3-bromopropyl)-2,2,5,5-tetramethyl-1-aza-disilacyclopentane.

23. (New) The functionalized polymer of claim 18, where at least one of X and Y includes an alkyl tin group or an amine group, and where at least one of X and Y includes an alkoxy silane or epoxide group.